Decision support systems to identify different species of malarial parasites

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Abstract

In this project, medical expert systems were designed to aid technicians, students and scientists in identifying various species of malarial parasite from blood smears. The rule based system was found to intelligently ask pertinent questions to accurately and efficiently identify the species of malarial parasite. The probabilistic system provided quantitative feedback as to the likelihood of a diagnosis of a species of malaria. Medical expert systems can potentially streamline the process of malarial species identification, and can aid in training new technicians and scientists in this important skill.

Introduction

Decision support systems or medical expert systems are created as an aid in decision making in healthcare[1]. The goals of such systems are to provide a methodological and accurate system that can mimic or model some aspect of healthcare knowledge. Some examples are automated differential blood count analyzers and cytological recognition systems for analyzing Pap smears[2]. Successful expert systems have a well defined focus and confined to a specific domain. Knowledge required to identify different species of malarial parasites could be well modeled in an expert system. Timely and accurate diagnosis of different species of malaria is essential to prevent mortality and morbidity. Acquiring expertise to identify different species of malarial parasite requires significant training and an expert supervision. An interactive tool which can help students and technicians gain expertise can be of great benefit.

Methods

The diagnosis of malaria rests on the demonstration of asexual forms of the parasite in peripheral blood smears subjected to Romanovsky staining. A literature search yielded various differentiating features of different species of parasite. The important feature categorization steps considered were: Identification, size and shape of red blood cells (RBCs), presence of stained parasite inside RBCs, presence of vacuole inside the parasite, ratio of vacuole to RBCs, presence of pigment granule (Hemozoin) inside parasite, shape, size and color of the Hemozoin pigment granule, and presence and number of Merozoites inside the parasite. A search tree, using the above factors was constructed.

Two expert systems were developed to aid in the diagnosis of malaria. A rule based decision support tool (CLIPS) was used to create the medical expert system. A limited Bayesian prototype was also developed in Netica, to compare and assess the usefulness of probabilistic systems. Certain assumptions were made to formalize the knowledge in both the rule based and Bayesian systems.

Results

The CLIPS system was successfully implemented and tested against the search tree to ascertain the accuracy of the system. The Bayesian prototype gave the probabilities of the species based on the various characteristics of the selected malaria species.

Discussion

The CLIPS system successfully asked the best question based on responses to previous questions in order to reach a goal state as fast as possible. This showed the value of a rule based system, especially when heuristics are used for diagnosis. Although the Bayesian system provided results based on estimated probabilities, accuracy could be improved with more specific information about the diagnostic probabilities of different characteristic features of the malarial parasite. Developing a clinical decision support tool that can encode human expertise is challenging. The difficulty lies in the lack of understanding of how people know what they know, the technical problems of structuring and accessing large amounts of knowledge in the system, and the lack of an objective gold standard that can be used to determine truth in medicine. Some assumptions made to represent knowledge may be addressed by frame based systems in future work.

References

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